

Syrian Arab Republic

Ministry of Education and Higher Education

Arab University for Science and Technology

Faculty of Computer Engineering



Third-(Part 1) Lecture

Modeling & Simulation

Lecturer Introduction

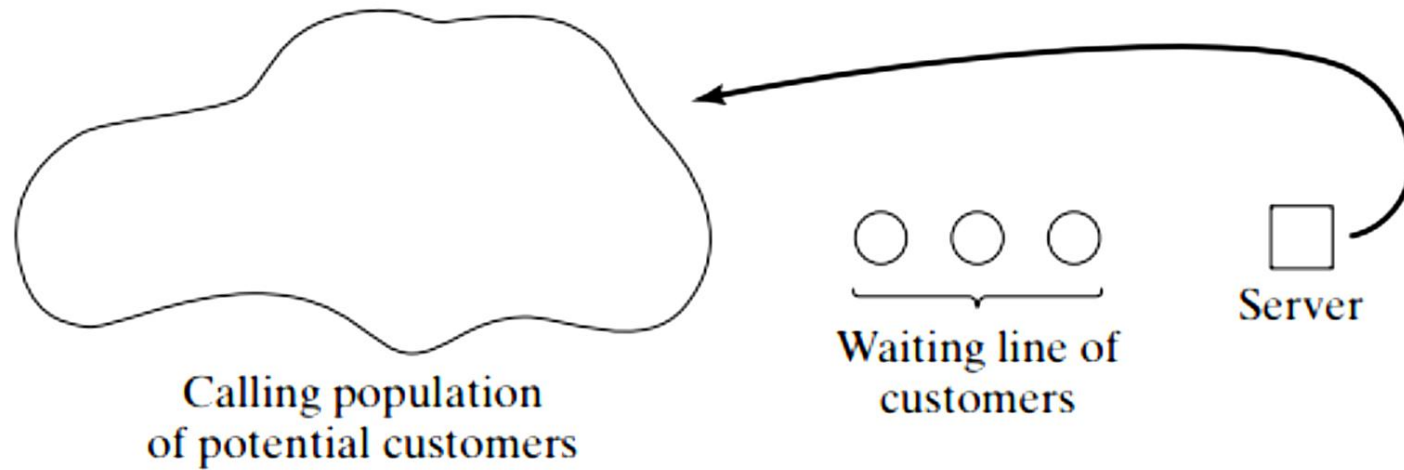
Dr. Radwan Sobhi Al-Mohammad

Agenda

- **Queueing Model.**
- **Queueing System Algorithms.**
- **Interarrival & Service Time.**
- **Idle & Busy System.**
- **Single Server Queue.**

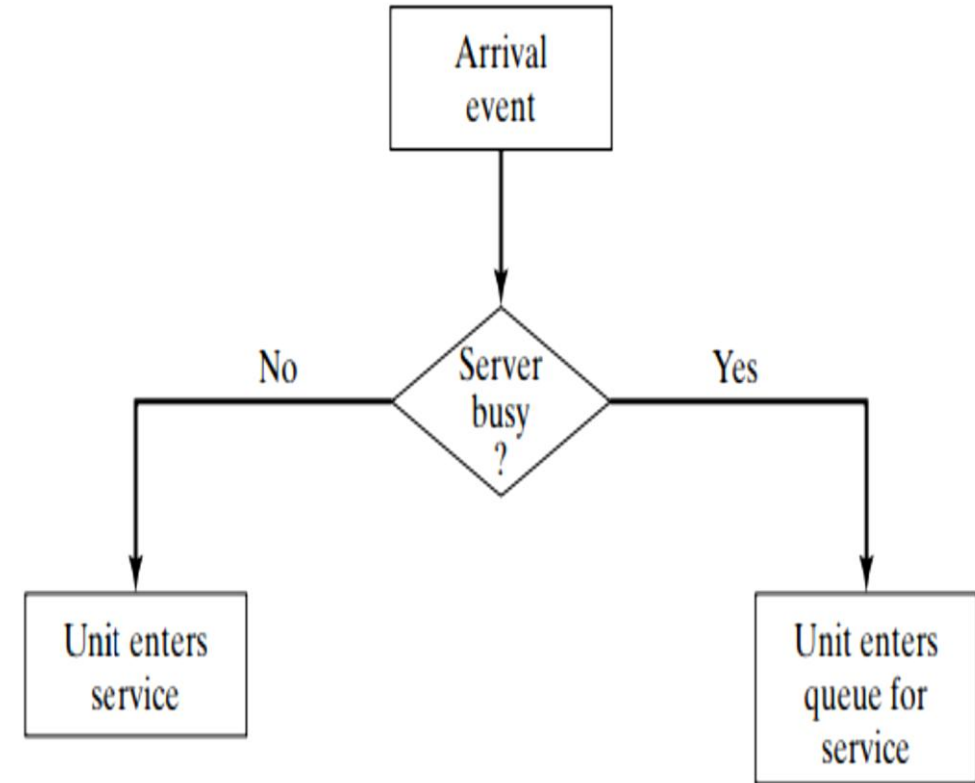
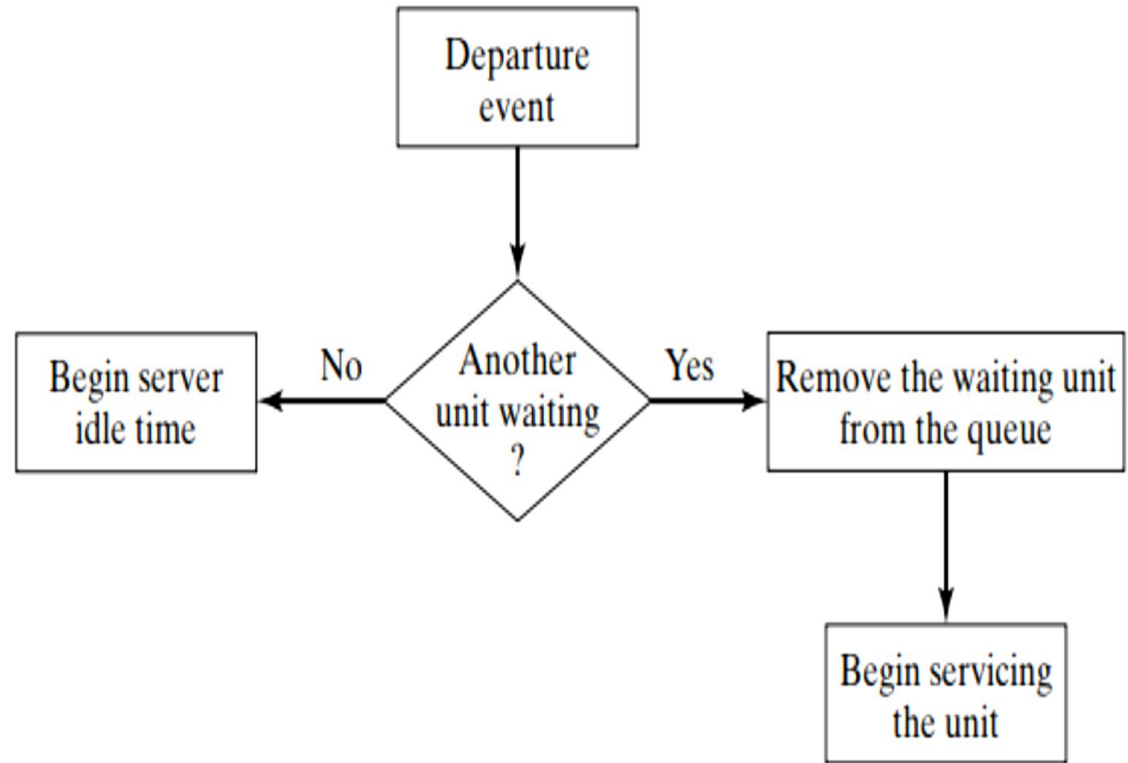
1- Queueing Model:

In **queueing model**, customers arrive from time to time and join a queue(waiting line), are eventually served, and finally leave the system.



Common queue include: first in first out (FIFO), last in first out (LIFO), service in random order (SIRO), shortest processing time first (SPT), and service according to priority (PR).

2- Queueing System Algorithms:



3- Interarrival & Service Time:

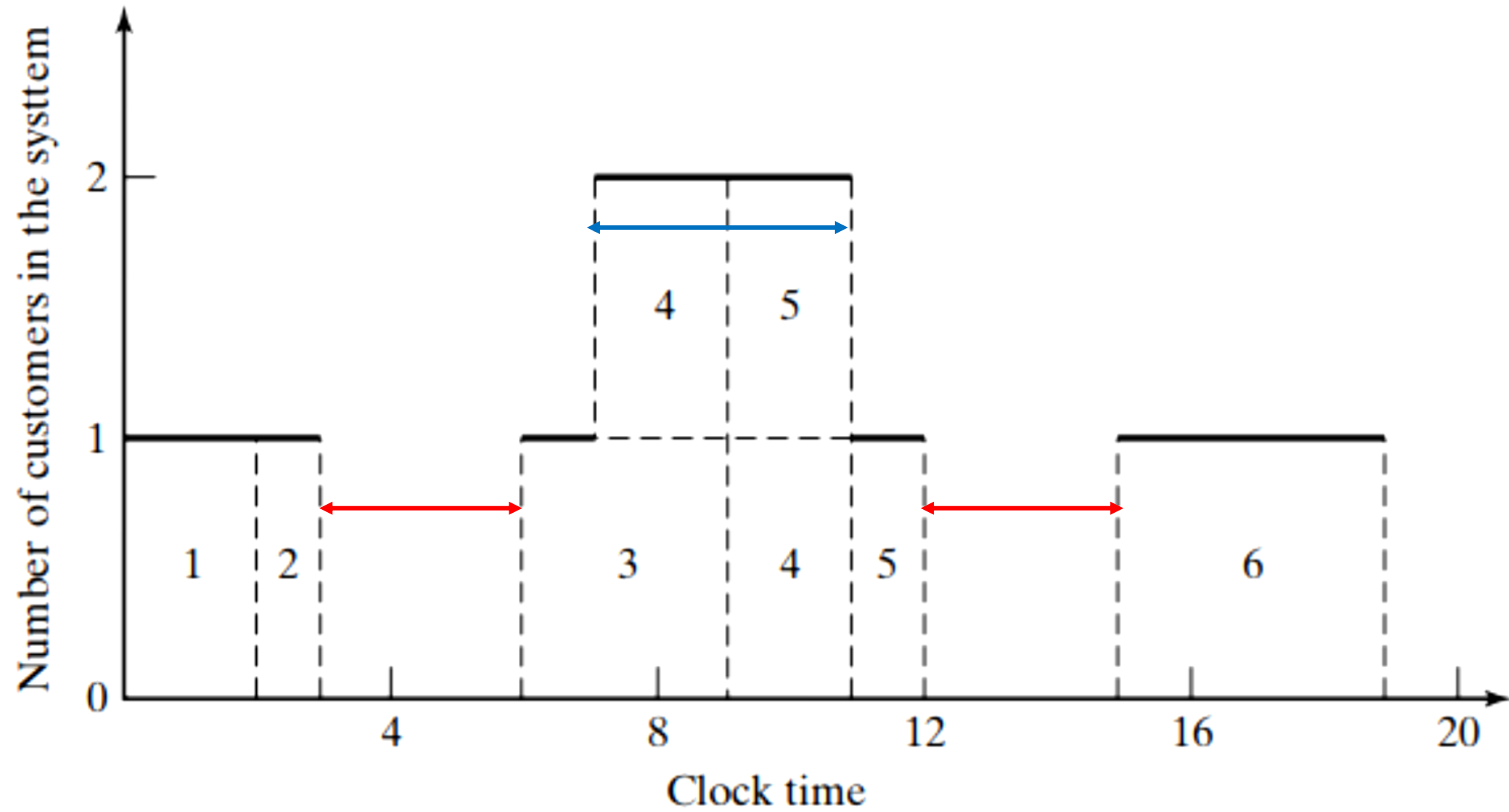
Customer	Interarrival Time	Arrival Time on Clock	Service Time
1	-	0	2
2	2	2	1
3	4	6	3
4	1	7	2
5	2	9	1
6	6	15	4

The interarrival and service times are taken from distributions!

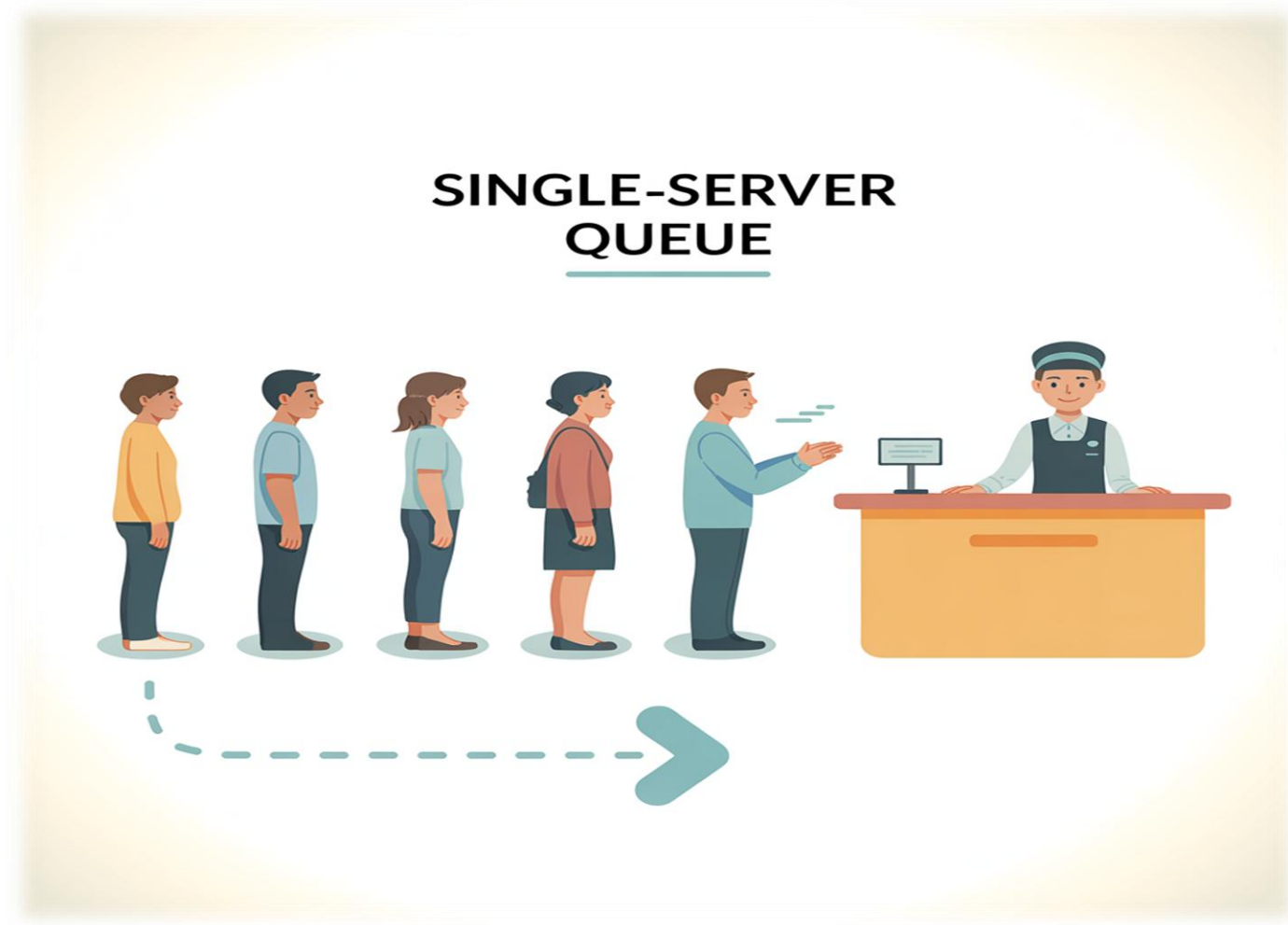
Customer Number	Arrival Time [Clock]	Time Service Begins [Clock]	Service Time [Duration]	Time Service Ends [Clock]
1	0	0	2	2
2	2	2	1	3
3	6	6	3	9
4	7	9	2	11
5	9	11	1	12
6	15	15	4	19

The simulation run is build by meshing clock, arrival, and service times!

4- Idel & Busy System:



5- Single Server Queue:



Example-1:

A small grocery store has one checkout counter. Customers arrive at the checkout counter at random times that range from 1 to 8 minutes apart. We assume that interarrival times are integer valued with each of the 8 values having equal probability; this is a discrete uniform distribution.

Interarrival Time [minute]	Probability	Cumulative Probability
1	0.125	0.125
2	0.125	0.250
3	0.125	0.375
4	0.125	0.500
5	0.125	0.625
6	0.125	0.750
7	0.125	0.875
8	0.125	1.000

<i>Time between Arrivals (Minutes)</i>	<i>Probability</i>	<i>Cumulative Probability</i>	<i>Random-Digit Assignment</i>
1	0.125	0.125	001–125
2	0.125	0.250	126–250
3	0.125	0.375	251–375
4	0.125	0.500	376–500
5	0.125	0.625	501–625
6	0.125	0.750	626–750
7	0.125	0.875	751–875
8	0.125	1.000	876–000

<i>Time between</i>			<i>Time between</i>		
<i>Customer</i>	<i>Random Digits</i>	<i>Arrivals (Minutes)</i>	<i>Customer</i>	<i>Random Digits</i>	<i>Arrivals (Minutes)</i>
1	—	—	11	109	1
2	913	8	12	093	1
3	727	6	13	607	5
4	015	1	14	738	6
5	948	8	15	359	3
6	309	3	16	888	8
7	922	8	17	106	1
8	753	7	18	212	2
9	235	2	19	493	4
10	302	3	20	535	5

The service times vary from 1 to 6 minutes (also integer valued), with the probabilities shown in the following table.

Service Time [minute]	Probability	Cumulative Probability
1	0.10	0.10
2	0.20	0.30
3	0.30	0.60
4	0.25	0.85
5	0.10	0.95
6	0.05	1.00

<i>Service Time (Minutes)</i>	<i>Probability</i>	<i>Cumulative Probability</i>	<i>Random-Digit Assignment</i>
1	0.10	0.10	01–10
2	0.20	0.30	11–30
3	0.30	0.60	31–60
4	0.25	0.85	61–85
5	0.10	0.95	86–95
6	0.05	1.00	96–00

<i>Customer</i>	<i>Random Digits</i>	<i>Service Time (Minutes)</i>	<i>Customer</i>	<i>Random Digits</i>	<i>Service Time (Minutes)</i>
1	84	4	11	32	3
2	10	1	12	94	5
3	74	4	13	79	4
4	53	3	14	05	1
5	17	2	15	79	5
6	79	4	16	84	4
7	91	5	17	52	3
8	67	4	18	55	3
9	89	5	19	30	2
10	38	3	20	50	3

Simulation System

Performance Measure

Customer	Interarrival Time [Minutes]	Arrival Time [Clock]	Service Time [Minutes]	Time Service Begins [Clock]	Time Service Ends [Clock]	Waiting Time in Queue [Minutes]	Time Customer in System [Minutes]	Idle Time of Server [Minutes]
1	—	0	4	0				
2	8		1					
3	6		4					
4	1		3					
5	8		2					
6	3		4					
7	8		5					
8	7		4					
9	2		5					
10	3		3					
11	1		3					
12	1		5					
13	5		4					
14	6		1					
15	3		5					
16	8		4					
17	1		3					
18	2		3					
19	4		2					
20	5		3					
Total	82		68					

Simulation System

Performance Measure

Customer	Interarrival Time [Minutes]	Arrival Time [Clock]	Service Time [Minutes]	Time Service Begins [Clock]	Time Service Ends [Clock]	Waiting Time in Queue [Minutes]	Time Customer in System [Minutes]	Idle Time of Server [Minutes]
1	—	0	4	0	4	0	4	0
2	8	8	1	8	9	0	1	4
3	6	14	4	14	18	0	4	5
4	1	15	3	18	21	3	6	0
5	8	23	2	23	25	0	2	2
6	3	26	4	26	30	0	4	1
7	8	34	5	34	39	0	5	4
8	7	41	4	41	45	0	4	2
9	2	43	5	45	50	2	7	0
10	3	46	3	50	53	4	7	0
11	1	47	3	53	56	6	9	0
12	1	48	5	56	61	8	13	0
13	5	53	4	61	65	8	12	0
14	6	59	1	65	66	6	7	0
15	3	62	5	66	71	4	9	0
16	8	70	4	71	75	1	5	0
17	1	71	3	75	78	4	7	0
18	2	73	3	78	81	5	8	0
19	4	77	2	81	83	4	6	0
20	5	82	3	83	86	1	4	0
Total	82		68			56	124	18

Thank you for listening